

(January 12, 1927)

USE OF THE PIEZO OSCILLATOR IN RADIO BROADCASTING STATIONS.\*

General

This Letter Circular considers one important application of the piezo oscillator, namely, its use in a broadcasting station for checking and assisting in the maintenance of a constant frequency close to the licensed value. This is not the same thing as automatic piezo control, in which the amplified output of a piezo oscillator is actually transmitted. The discussion herein is in two parts, viz., suggestions for the construction of the piezo oscillator and specific instructions for the particular use just mentioned. Information on construction of a piezo oscillator for general purposes is given in this Bureau's Letter Circular 186, which may be obtained upon request from the Bureau of Standards. Blueprints also will be furnished to persons actually contemplating the construction of the device. The present Letter Circular is supplementary to Letter Circular 186 in respect to the construction of the piezo oscillator.

The modifications described herein render the construction somewhat simpler and less expensive than the construction outlined in Letter Circular 186. Other types of piezo oscillators are suitable for checking the frequency of a broadcasting station by the methods described in this Letter Circular.

Automatic piezo control, that is, where the piezo oscillator is made a part of the transmitting circuits, is probably the best method of frequency regulation, the chief advantage being the elimination of errors in observation and adjustment. However, this condition may in itself constitute a disadvantage since in case of failure of the piezo control to function properly the trouble may not become known for a considerable time. The incorporation of automatic piezo control is elaborate and expensive. On the other hand, the use of the piezo oscillator as a separate device for checking is a very simple matter because no modifications whatever are required in the transmitting set.

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The use of the piezo oscillator as a separate device for checking has been found by the Bureau of Standards to be useful and satisfactory, and has two distinct advantages over a frequency indicator, frequency meter, or any similar device which indicates the proper adjustment by maximum deflection of a needle moving over a scale. First, it is a particularly constant frequency standard, since when properly designed the frequency it delivers depends only on mechanical constants of the quartz plate. Second, the indication of a piezo oscillator is unaffected by fluctuations in the station's power or degree of modulation. For this reason it may be used to check the frequency of the broadcasting station with equal accuracy under all conditions of operation. A caution required in using the piezo oscillator, as compared to a device using a visual indicator, arises from the fact that some confusion may be caused by the production of beats from so-called fractional harmonics. This difficulty is overcome by familiarity with the use of the piezo oscillator and by securing an initial adjustment of the transmitting set giving approximately the required frequency. In cost, the piezo oscillator is about equal to that of a well designed frequency indicator\* or equivalent instrument.

Modifications over Specifications in Letter Circular 186.-  
The following changes in the Letter Circular 186 specifications simplify the construction and give an instrument satisfactory for this purpose.

Blueprint Sheet No.1 (with Letter Circular 186).- Omit switch 13, points F and P and switch stops. Location of this switch is shown near upper right hand corners of two plan views, Sheet No.1. When wiring the circuit, make connections as if switch 13 were on point F.

Blueprint Sheet No.2 (with Letter Circular 186).- Changes in wiring as follows: wire directly from terminal eleven to terminal marked "-A". Omit wire leading from switch point P.

Blueprint Sheet No.3 (with Letter Circular 186).- Make one coil form instead of two, also one pair of spring catches for holding coil in cover of cabinet instead of two pair. (See Letter Circular 186, page 3, last paragraph). This coil form is wound with a single layer of No.24 AWG (B&S) double cotton covered wire. The approximate number of turns is determined by the frequency of the broadcasting station in which the piezo oscillator is to be used. If this frequency is below about 800 kilocycles, 40 turns are satisfactory; for frequencies higher than this, about 25 turns should be used. The turns specified assume the use of a 0.001 microfarad variable condenser (blueprint sheet No.1 accompanying LC 186).

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\* See Bureau of Standards Letter Circular 180.





Care and Operation of the Piezo Oscillator.

The quartz plate with its holder should be considered as a unit and should not be opened. The plate and holder should be used in the same position in which they were when the device was calibrated. Reversing the position may cause a slight change in frequency.

Dry batteries may be used to supply the necessary power to the piezo oscillator. It is very desirable that these be placed in a battery box with convenient connection terminals plainly marked which are connected to the piezo oscillator with flexible insulated leads. If a dry cell A-battery is employed the filament rheostat should at all times be turned off when the piezo oscillator is not actually in use; otherwise frequent renewals will be necessary. The use of a storage A-battery is to be preferred. Failure of the piezo oscillator to operate may be due to defective A or B batteries or a defective tube. Occasionally trouble may be due to the quartz plate sticking in the holder and this may be overcome by shaking the holder slightly.

Use in Checking Frequency of Broadcasting Station.

After the quartz plate has been adjusted to the licensed frequency of the broadcasting station (see instructions in Letter Circular 186) the piezo oscillator is ready for use in checking the frequency of that station. The piezo oscillator is placed in the operating room in a convenient location for listening in the headphones and making the necessary frequency adjustment of the transmitting set. The most satisfactory location is determined by trial. If the piezo oscillator is too close to the source of power its operation may be unsteady as evidenced by jerking of the needle of the milliammeter. If too far away, a beat note of satisfactory intensity will not be obtained. If necessary, the leads to the headphones may be lengthened in order that the same observer may make the adjustment of the transmitting circuit while listening to the beat note in the phones of the piezo oscillator.

In the initial use it is very desirable that some form of frequency meter (wavemeter) be used to obtain an approximate frequency adjustment of the transmitting set and also to ensure that the beat note obtained in the phones of the piezo oscillator is produced by the fundamental frequencies. After a little experience has been gained in the use of the piezo oscillator it should not be necessary to employ an auxiliary measuring instrument.

After making an approximate adjustment of the transmitting set to obtain a frequency differing by not more than about ten kilocycles from the piezo oscillator, a beat note will be heard in the phones of the piezo oscillator. This beat is caused by the interaction of the two frequencies. The frequency of the transmitting set is then adjusted in such a manner that the pitch of the beat note becomes lower and lower. The adjustment is carefully con-



tinued until zero beat is produced; that is, the condition where the beat is no longer audible in the headphones of the piezo oscillator but reappears when the frequency of the transmitting set is increased or decreased slightly. This indicates that the transmitting set is very accurately adjusted to the frequency of the piezo oscillator. This condition should be checked at intervals by listening in the headphones to ascertain that a constant frequency is being maintained. Care should be taken to see that the piezo oscillator is generating at all times when the frequency of the transmitting set is being checked, otherwise it may appear that a zero beat adjustment is being maintained when actually the frequency of the transmitting set has shifted.

#### Constant Frequency Stations.

A list of certain broadcasting stations designated as "constant frequency stations" is published monthly by the Bureau of Standards in the Radio Service Bulletin. Each of those stations employs a special device for maintaining its frequency close to the licensed value and by virtue of fulfilling certain conditions is of value to the public as a standard of frequency. The piezo oscillator is the most commonly used device for this purpose. The conditions prerequisite to inclusion in the published list are: the frequency calibration of the device must be in agreement with the frequency standard of the Bureau of Standards; a special procedure (frequency check at short intervals) must be followed in the use of the device to maintain constant frequency of the transmitting station; and the transmitting set, antenna, etc., must be of such design and construction as to be suitable for accurate frequency maintenance.

Broadcasting stations not included in the list of standard frequency stations or the list of constant frequency stations and which utilize the piezo oscillator as described in this Letter Circular are invited to communicate with the Bureau of Standards giving details of the method of checking the station frequency and information concerning the transmitting equipment which would have a bearing on the constancy of the radiated frequency. Detailed information is given in Letter Circular 214, "Requirements of Constant Frequency Stations," which may be obtained upon request.

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